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Neuro-Occlusal Rehabilitation (NOR) in the Early Treatment of Malocclusion in Primary Dentition: A Scoping Review

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Abstract

Introduction: Neuro-Occlusal Rehabilitation (NOR) is a therapeutic approach to stomatognathic medicine aiming to treat dental malocclusion in children early, using techniques based on neuroplasticity and craniofacial development principles. It acts by physiologically exciting or controlling the neural centers of development, thus guiding the growth of the system.

The objective is to highlight this method as an alternative to conventional orthodontics in the treatment of occlusal problems, since its use in deciduous dentition is interesting not only because it accompanies and directs.

the correct growth of an individual's stomatognathic system, but also because it achieves a lasting morphological and functional balance, thus limiting possible future relapses.

Methods: A Scoping Review was carried out in order to observe the impact of the use of NOR in the treatment of different types of malocclusions in children in the deciduous dentition phase. To this end, a search was carried out in various databases, including PubMed, Cochrane Library, Scopus, SciELO, Semantic Scholar and ScienceDirect, from which 9 articles were extracted.

Results: Occlusal problems were resolved in children with deciduous teeth and malocclusion pathologies, using appliances and techniques based on the principles of NOR.

Conclusions: The use of this technique at an early age seems promising for solving malocclusion problems in children, due to its ability to redirect the growth of the stomatognathic system. However, the lack of scientific evidence in this area does not allow us to draw firm conclusions. Many more studies are needed to prove the effectiveness of this line of thinking.

Keywords

Deciduous dentition; Malocclusion; Functional Jaw Orthopaedics; Neuro-Occlusal Rehabilitation.

Introduction

According to the World Health Organization, malocclusion is the third most prevalent oral pathology, after dental caries and periodontal disease [1]. Occlusion is established by the interaction between the maxillary teeth and the mandibular teeth when they come into contact [1]. Malocclusion is defined as a change in tooth alignment and/or in the relationships between teeth during occlusion [2]. There are several types of malocclusions, according to direction: vertical, transverse, and sagittal [1]. Vertical malocclusions can present as a deep bite or an open bite. Transverse malocclusion is described as a posterior [3,4], or anterior [5] crossbite, [1,3] or as a scissor bite.[1] Sagittal malocclusions comprise three types: class I, class II and class III malocclusions [6].

The treatment of malocclusion is essential, as it can lead to impairment of some functions, such as chewing, swallowing, and diction [2]. According to the literature, some individuals experience clicking in the temporomandibular joint (TMJ) when opening and closing the mouth, orofacial pain, earache, migraine, pain or discomfort during chewing, difficulties when opening and closing the mouth, but also difficulties in oral hygiene [1]. In addition to these functional aspects, malocclusion has a real impact on the self-esteem of individuals, due to the great aesthetic component associated with it [2].

Founded by Dr. Pedro Planas, [7] NOR is a preventive practice that provides early diagnosis and treatment of deviations in the development of the stomatognathic system [7,8]. Intervention during this period of an individual's life, when the potential for biological development and bone remodelling is great, favours facial growth without leaving sequelae, and guarantees a better prognosis [3]. In this way, surgical

procedures are avoided later in the patient's life [8]. By achieving these goals at an early age, it permits the elimination and/or reduction of relapses [7].

It acts by physiologically exciting or controlling the neural centres of development [8,13] through the production of neural stimuli in the sensory neurons of the mouth (at the level of the periodontal ligaments, the TMJs, the facial muscles, the tongue, and the mucous membranes), [9] thus guiding the growth of the stomatognathic system to a situation of morphological and functional balance, where there is harmony between all dental, joint and muscular structures [8,13]. According to the literature, this is achieved through the use of simple and non-aggressive removable specific appliances, which should not harm the remaining tissues of the system [7]. A well-developed stomatognathic system promotes then pleasant aesthetics, achieved through proper dental alignment, facial harmony, and a good facial profile [7].

The elimination of parafunctional habits such as digital sucking, [1,10] non-physiological pacifier sucking, [10] object biting, [10] mouth breathing, [1,7,10] bottle feeding, [7,10] atypical swallowing [1,10] and onychophagia, [10] allows a return to a physiological growth pattern of the bone bases, if corrected in good time [7]. The adoption of an adequate fibrous diet is also a fundamental principle for the correction of malocclusion [11].

According to the literature, selective wear of some cusps in deciduous dentition permits to achieve a balanced occlusion [12]. It is considered to be the "true prophylactic therapy"7 to be applied in deciduous dentition because it mimics the physiological wear that should normally occur when a child reaches the age of 6, i.e., a situation in which the occlusal surfaces are worn and flat [7,8]. It consists of a procedure in which tooth structure is removed until the tooth establishes contacts that improve the overall contact pattern and lateral displacement movements of the mandible [12].

According to the authors, Direct Planas Tracks are made by inserting light-curing composite resin in inclined planes, following the protocol established for adhesive restorations. The composite resin is placed on inclined planes that conform to the dental anatomy [3].

Indirect Planas Tracks do not act by exerting pressure, force, or retention, but by simple presence. This presence action is characterized by a slight tooth movement of lingual-vestibular release, which occurs as a result of the placement of this appliance. This appliance permits to re-establish a physiological occlusal plane, without traumatizing the periodontium and leaving the lateral movements of the mandible free, resulting in greater patient satisfaction [7,8].

They should be worn all day and night, except during meals, which is when the masticatory act is performed, launching the neural stimuli. After the meal, the appliance is placed in the mouth again, as this is the time when the development of the stomatognathic system is most intense [7,8]. This appliance corrects the distal positions of the mandible to bring it spontaneously into a neutrocclusion position, just by changing the inclination of the track, according to the principles of the Law of Minimum Vertical Dimension [7].

The Equi-Plan is a stainless-steel metal accessory placed on the bottom plate of the Planas appliance and interposed between the upper and lower incisors. It is used in particular to treat overbite [7,8]. From the principles of NOR comes Functional Jaw Orthopaedics (FJO), which acts through its fundamentals. According to the authors Simões, Valério and Duarte, FJO is the area of dentistry that works to remove pathological stimuli in the growth and development of the stomatognathic system, through neuromuscular intervention. By awakening desirable physiological stimuli, FJO triggers the correct development of the bone bases, which results in a functional and aesthetic relationship between the dental arches [13].

Although FJO is inspired by the concepts of NOR, this area has developed its own techniques, approaches, and appliances for the treatment of malocclusion [9]. Orthopaedic appliances are removable and numerous, each one adapted to the needs of each case, so they won't be detailed here. The aim of this Scoping Review is to present a different approach to conventional orthodontics in the treatment of occlusal problems, starting with the deciduous dentition, in order to limit possible recurrences and treat the individual as a whole, to achieve a lasting morphological and functional balance. This therapy could avoid later compensatory or highly invasive treatments in adolescents and adults.

Material and Methods

As this study is a Scoping Review, since no clinical intervention was performed and there was no involvement of patients, the collection of personal data was not required. The research was conducted following the methodology outlined by the Joanna Briggs Institute (JBI) for Scoping Reviews.

Research question

The research question addressed in this study was structured according to the PCC (Population, Concept, and Context) strategy recommended by JBI for Scope Reviews. Based on this framework, the research question was formulated as follows: What is the impact of Neuro-Occlusal Rehabilitation (Concept) on the treatment of malocclusion (Context) in children with primary dentition (Population)?

Research strategy

In accordance with the PRISMA-ScR (Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews) guidelines, electronic searches were conducted across multiple databases, including PubMed, Cochrane Library, Scopus, SciELO, Semantic Scholar, and ScienceDirect, using the following keywords: Neuro-Occlusal Rehabilitation, Functional Jaw Orthopaedics, Orthopaedics and Function, selective grinding, Planas Direct Tracks, Planas Indirect Tracks. To yield a comprehensive search outcome, articles published in the last two decades were included in this study. The survey was carried out as described in Table 1.

Database	Filter used	Research method
PubMed	[Title] [Years] 2004-2024	"(Neuro-Occlusal Rehabilitation) AND ((deciduous OR primary OR temporary) dentition)"

		"(Functional Jaw Orthopedics) AND ((deciduous OR primary OR temporary) dentition)" "(Selective wear) AND ((deciduous OR primary OR temporary) dentition)" "Planas Direct Tracks) AND ((deciduous OR primary OR temporary) dentition)" "Planas Indirect Tracks) AND ((deciduous OR primary OR temporary) dentition)"
Cochrane Library	[Title, Abstract, Keyword]	"(Neuro-Occlusal Rehabilitation) AND ((deciduous OR primary OR temporary) dentition)" "(Functional Jaw Orthopedics) AND ((deciduous OR primary OR temporary) dentition)" "(Selective wear) AND ((deciduous OR primary OR temporary) dentition)" "Planas Direct Tracks) AND ((deciduous OR primary OR temporary) dentition)" "Planas Indirect Tracks) AND ((deciduous OR primary OR temporary) dentition)"
Scopus	[Title]	"(Neuro-Occlusal Rehabilitation) AND ((deciduous OR primary OR temporary) dentition)" "(Functional Jaw Orthopedics) AND ((deciduous OR primary OR temporary) dentition)" "(Selective wear) AND ((deciduous OR primary OR temporary) dentition)" "Planas Direct Tracks) AND ((deciduous OR primary OR temporary) dentition)" "Planas Indirect Tracks) AND ((deciduous OR primary OR temporary) dentition)"
SciELO	[Title]	"(Neuro-Occlusal Rehabilitation) AND ((deciduous OR primary OR temporary) dentition)" "(Functional Jaw Orthopedics) AND ((deciduous OR primary OR temporary) dentition)" "(Selective wear) AND ((deciduous OR primary OR temporary) dentition)" "Planas Direct Tracks) AND ((deciduous OR primary OR temporary) dentition)" "Planas Indirect Tracks) AND ((deciduous OR primary OR

		temporary) dentition)”
Semantic Scholar	[Title]	“(Neuro-Occlusal Rehabilitation) AND ((deciduous OR primary OR temporary) dentition)” “(Functional Jaw Orthopedics) AND ((deciduous OR primary OR temporary) dentition)” “(Selective wear) AND ((deciduous OR primary OR temporary) dentition)” “Planas Direct Tracks) AND ((deciduous OR primary OR temporary) dentition)” “Planas Indirect Tracks) AND ((deciduous OR primary OR temporary) dentition)”
ScienceDirect	[Title] [Years] 2004-2024	“(Neuro-Occlusal Rehabilitation) AND ((deciduous OR primary OR temporary) dentition)” “(Functional Jaw Orthopedics) AND ((deciduous OR primary OR temporary) dentition)” “(Selective wear) AND ((deciduous OR primary OR temporary) dentition)” “Planas Direct Tracks) AND ((deciduous OR primary OR temporary) dentition)” “Planas Indirect Tracks) AND ((deciduous OR primary OR temporary) dentition)”

Table 1: Search methodology adopted in the different databases.

Types of Studies

Quantitative, qualitative, or mixed-methods studies were eligible for inclusion. Comparative, longitudinal, cross-sectional, descriptive, controlled, clinical trials, meta-analyses, systematic reviews, and narrative reviews were considered.

Types of Participants

Articles were selected if the sample individuals had primary dentition, representing patients from the paediatric population, typically under six years of age.

Inclusion Criteria

Inclusion criteria for this study comprised Neuro-Occlusal Rehabilitation and Functional Jaw Orthopaedics in primary dentition, encompassing various types of malocclusions. Accepted languages for articles are English, Portuguese, Spanish, and French. Considering the current research is dated 2024 and articles published over the past two decades were selected, the temporal scope of accepted publications spans from 2004 to 2024.

Exclusion Criteria

Exclusion criteria include any other type of orthodontic treatment besides NOR or FJO. Conventional Orthodontics and Myofunctional Therapy, mixed or permanent dentition population, syndromic patients, treatments for dental pathologies other than malocclusion, neurological and neuromuscular pathologies, articles on clinical cases or case studies, and studies not conducted in humans were also excluded.

Results

In the Figure 1, we can observe that the search conducted across the six afore mentioned databases resulted in 579 articles, out of which 145 were duplicates. Following the selection process, 9 articles meeting the inclusion criteria were chosen. Among these, 8 articles were quantitative studies, and one was a qualitative study. Studies conducted over the past two decades were considered. The scarcity of currently available scientific evidence on this topic precluded standardization and comparison of the results among them.

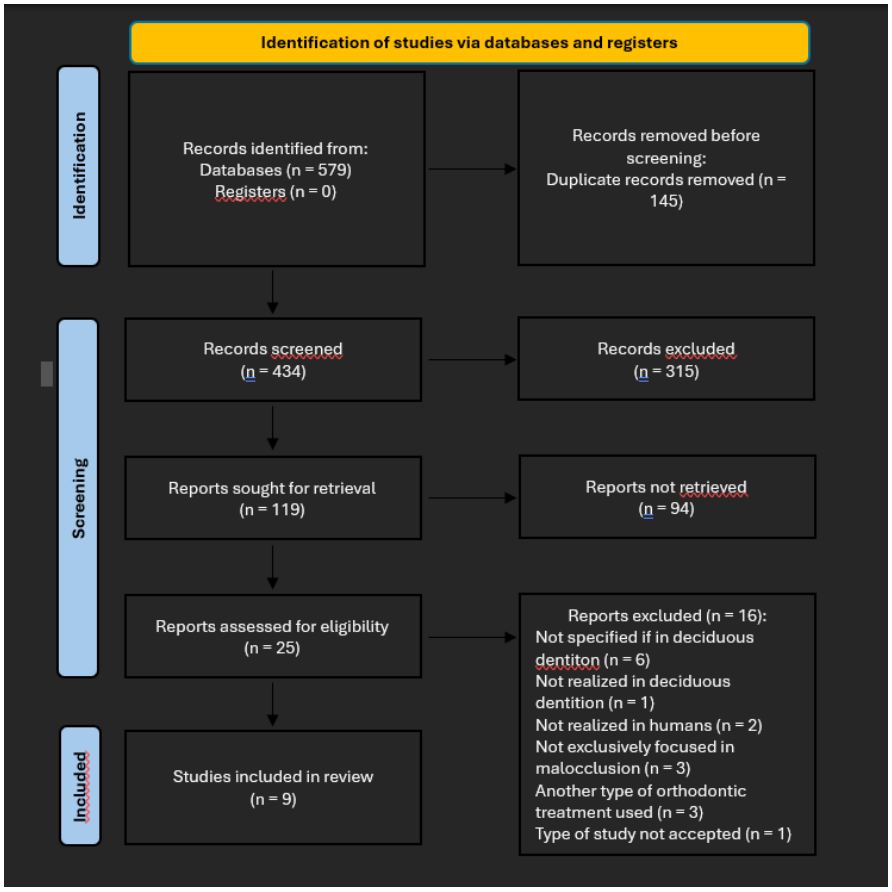

Figure 1: Prisma-Scr (Preferred Reporting Items for Systematic Reviews and Meta-Analyses extension for Scoping Reviews) flowchart of the study selection process.

The detailed list of studies selected for this Scoping Review is provided in Table 2, as well as their results.

Timetable for oral prevention in childhood – developing dentition and oral habits: a current opinion (Majorana et al., 2015)	
Year	2015
Authors	Majorana, A. ; Bardellini, E. ; Amadori, F. ; Conti, G. ; Polimeni, A.
Journal of publication	Progress in Orthodontics
Type of study	Narrative review
Database	PubMed
Participants	–
Type of malocclusion corrected	Unspecified type of malocclusion
Intervention	- Cessation of deleterious habits
	- Breastfeeding
Duration of the intervention	36 months
Methodology	–

Results/Conclusions	- Breastfeeding promotes normal jaw development, proper tongue and lip posture, nasal breathing, and corrects the transverse diameter of the palate
	- Bottle feeding nutrition promotes malocclusion and predisposes children to develop non-nutritive sucking habits

	- Non-nutritive sucking promotes posterior crossbite, open bite, and Class II malocclusion in primary dentition
	- Mouth breathing promotes an increase in facial height, anterior open bite, increased overjet, narrow palate, and Class II skeletal malocclusion
Gaps in the research	- Unspecified type of malocclusion

	- Lack of precision in associating a specific type of behavior with the onset of a particular type of malocclusion
2: Efectos del tratamiento temprano en las variables funcionales con técnicas de la rehabilitación neuro-oclusal (Jiménez Yong et al., 2016)	
Year	2016
Authors	Jiménez Yong, Y. ; Véliz Concepción, O. L. ; Jiménez Mesa, L. ; Grau Abalo, R.
Journal of publication	Acta Médica del Centro
Type of study	Longitudinal and descriptive study
Database	SciELO

Participants	46 children
	(5 years old)
Type of malocclusion corrected	Occlusal interferences (abnormal sliding from Centric Relation to Maximal Intercuspidation or strictly during lateral movements)
Intervention	- Selective wear
	- Elimination of deleterious habits and diet control
Duration of the intervention	- Short-term treatment: 1 year
	- Long-term treatment: 8 years
Methodology	Stratified staged method:

	- 1st assessment: 1 year after the start of treatment
	- 2nd assessment: Intermediate (children at 10 years of age)
	- 3rd assessment: Final

Results/Conclusions	- 85.19% of the children resolved the problem of interferences in sliding from CR to MIP within 3 months, and 100% of the children with this issue were able to resolve it by the end of treatment, with highly significant results

	- 91.67% of the children with occlusal interferences during lateral movements resolved the problem within the first year of treatment, with 100% of the children resolving the issue in the long term, with highly significant results

	- During short-term treatment, 88.9% of the children with initial right unilateral chewing function achieved bilateral alternating chewing
	- During short-term treatment, 84.6% of the children with initial left unilateral chewing function achieved bilateral alternating chewing
Gaps in the research	–

3: Cambios de los arcos dentales deciduos clase I con apiñamiento, utilizando pistas planas directas. Medellín 2012-2013 (Hernández et al., 2014)	
Year	2014
Authors	Hernández, J. J. ; Gaviria, D. M. ; Londoño, E. ; Llano, C. ; Llano, M. C.
Journal of publication	Revista CES Odontología
Type of study	Descriptive study
Database	Semantic Scholar
Participants	6 children – 3 boys and 3 girls
	(4-5 years old)
Type of malocclusion corrected	Class I malocclusion with anterior dental crowding

Intervention	Planas Direct Tracks
Duration of the intervention	12 months
Methodology	- Initial model fabrication, mounting on an articulator, fabrication, and cementation of Direct Flat Tracks
	- Fabrication of models at 6 and 12 months intervals to observe differences

Results/Conclusions	- Average increase of 1.1 mm in maxillary intercanine distance, with a maximum of 2.19 mm at 6 months and 2.54 mm at 12 months
	- Increase in intermolar distance by an average of 2 mm, with a maximum value of 2.04 mm at 6 months and 2.79 mm at 12 months

	- The available space in the right maxilla showed a maximum increase of 0.44 mm at 6 months and 0.99 mm at 12 months.
	- Statistically significant increase of 0.9 mm in maxillary arch at the first 6 months and 2 mm after 12 months
	- No significant difference in the mandibular arch

Gaps in the research	The study sample is small, requiring further studies with a larger sample size
4: Assessment of treatment for functional posterior cross-bites in patients at the deciduous dentition phase (Tannus Dutra et al., 2004)	
Year	2004
Authors	Tannus Dutra, A. L. ; Cardoso, A. C. ; Locks, A. ; Barreto Bezerra, A. C.
Journal of publication	Brazilian Dental Journal
Type of study	Longitudinal study
Database	SciELO
Participants	26 children
	(2-6 years old)

Type of malocclusion corrected	Posterior crossbite
Intervention	Selective wear
Duration of the intervention	12 months
Methodology	- Group 1: 13 children with posterior crossbite undergoing treatment
	- Group 2: 13 children with posterior crossbite serving as the control group
Results/Conclusions	- 100% of the 13 children treated with selective grinding achieved correction of the posterior crossbite

	Stability of correction observed 12 months after treatment
	- No cases of self-correction in the control group
Gaps in the research	All treated children achieved correction of malocclusion due to treatment, with no cases of self-correction, which may not reflect real-world conditions found in other studies

5: Neuroclusal rehabilitation and planas direct tracks in the posterior crossbite treatment (Ipster Garbin et al., 2017)	
Year	2017
Authors	Ipster Garbin, A. J. ; Wakayama, B. ; Adas Saliba Rovida, T. ; Adas Saliba Garbin, C.
Journal of publication	Revista Gaúcha de Odontologia
Type of study	Clinical study
Database	SciELO
Participants	43 children
	(3-6 years old)
Type of malocclusion corrected	Posterior crossbite
Intervention	Planas Direct Tracks
Duration of the intervention	3 months

Methodology	Follow-up every 15 days
Results/Conclusions	- Posterior crossbite corrected in 34 children (79% of the sample), while the other 9 (21% of the sample) were non-compliant, with visible results between 14 and 91 days after the start of treatment

	- A higher proportion of posterior crossbite correction is observed on the 63rd and 70th day of treatment among patients aged 3 to 5 years
	- Of the 79.4% of participants with deleterious sucking habits, 94.1% ceased by the end of treatment
	- Correction of deviated midline observed in 100% of the sample

Gaps in the research	It would be interesting to have a follow-up of this study in the subsequent years
6: Evaluation of treatment for functional posterior crossbite of the deciduous dentition using Planas' direct tracks (Chibinski et al., 2011)	
Year	2011
Authors	Chibinski, A. C. R. ; Czlusniak, G. D.
Journal of publication	Indian Journal of Dental Research
Type of study	Comparative study
Database	PubMed
Participants	20 children
	(4-6 years old)

Type of malocclusion corrected	Functional posterior unilateral crossbite
Intervention	Planas Direct Tracks
Duration of the intervention	4 months
Methodology	- Test group: 10 children with functional posterior crossbite
	- Control group: 10 children with normal occlusion

Results/Conclusions	- At the end of the 4 months, the test group showed an increase of 5.78% in intercanine distance and 2.03% in intermolar distance. In the control group, these differences were 2.15% and 4.15%, respectively.

	- After 4 months, the control group showed no changes in the Carrea analysis (arch perimeter), while the test group had an increase of 2.22%
Gaps in the research	It would be interesting to have a follow-up of this study in the successive years
7: Efficacy of Planas Direct Tracks for Early Treatment of Pseudo Class III Malocclusion: A Clinical and Cephalometric Study (Vora et al., 2014)	
Year	2014

Authors	Vora, K. S. ; Misal, A. ; Toshniwal, N. ; Patil, S.
Journal of publication	Journal of Indian Orthodontic Society
Type of study	Prospective cross-sectional study
Database	ScienceDirect
Participants	7 children – 3 boys and 4 girls)
	(average age of 5.3 years)
Type of malocclusion corrected	Pseudo Class III (Anterior crossbite)
Intervention	Planas Direct Tracks
Duration of the intervention	6 months

Methodology	Comparison of pre- and post-treatment lateral cephalometric radiographs
Results/Conclusions	- Significant increase in overjet: changed from -2.14 ± 0.35 to -1.14 ± 0.83 after 6 months of treatment
	- Significant reduction in overbite: changed from 2.33 ± 0.46 to 0.71 ± 0.45 after 6 months of treatment

	- Statistically significant decrease in linear distance of the mesial step of the second deciduous molar with treatment
	- No significant difference in the SNA angle

		- Statistically significant decrease in the average SNB angle value: changed from 81.78 ± 0.83° to 80.29 ± 1.28° after 6 months of treatment
		- Statistically significant decrease in the average SN-Pog angle value: changed from 82.43 ± 0.49° to 80.86 ± 0.83° over a period of 6 months

		- Statistically significant increase in the ANB angle: changed from 1° to 2.14 ± 0.63° after treatment
		- Statistically significant increase in anterior and posterior facial height after treatment: the average anterior facial height changed from 90.86 ± 3.27° to 94.86 ± 3.98°, and the average posterior facial height changed from 63.29 ± 3.41° to 64.0 ± 3.5°

	- Statistically significant increase in the average mandibular plane angle: changed from 25.57 ± 3.45° to 28.57 ± 3.92°
	- Significant increase in lower facial height
	- Significant alteration in the inclination of lower and upper incisors

Gaps in the research	The study was limited to a period of 6 months. Ideally, it should have continued to promote retention, as well as to allow for the eruption of all adjacent teeth, in order to achieve proper occlusion.

8: The effect of combined maxillary pad movable appliance and FR-III functional appliance in the treatment of skeletal Class III malocclusion of deciduous teeth (Lyu et al., 2022)	
Year	2022
Authors	Lyu, L. ; Lin, H. ; Huang, H.
Journal of publication	BioMed Central Oral Health
Type of study	Retrospective study
Database	PubMed
Participants	30 children – 13 boys and 17 girls
	(5,25 ± 1,25 years old)
Type of malocclusion corrected	Skeletal Class III

Intervention	JFO (Combination of Maxillary Pad Movable Appliance and Fränkel III Functional Regulator Appliance)
Duration of the intervention	3 years
Methodology	- 1st step: Use of the Maxillary Pad Movable Appliance all day
	- 2nd step: Use of the FR-III (Fränkel III Functional Regulator Appliance)

	Comparison of pre- and post-treatment lateral cephalometric radiographs
Results/Conclusions	- Average increase in SNA position of 1.29° and sagittal bone mass of the maxilla
	- Average decrease of 0.71° in SNB position and relative retrusion of the mandible

	- Average increase of 1.98° in the sagittal relationship between ANB and the maxilla
	- Average increase in the relative maxillary protrusion index of 1.93°, with statistically significant difference
	- Non-statistically significant decrease in mandibular retrusion index (average of 0.73°)

	- Average increase of 1.86° in the Y-axis angle of chin development index, with well-developed chin
	- Average increase of 0.71 mm in Po-NB distance, 0.76° in FH-MP, 0.31° in PM-SN, and 0.86° in SN-FH, without statistical significance and vertical change

	- Increase in labial inclination of upper anterior teeth by an average of 17.24°
	- Increase in inclination and prominence of upper incisors, approaching normal
	- Improvement in labial inclination of lower anterior teeth, with an average increase of 8.07°

	- Inclination and prominence of upper incisors remained insufficient after treatment, but there was improvement	
	- Indices of the upper and lower arches significantly improved, with an average decrease of 25.53°, indicating better coordination between protrusions of upper and lower incisors	

	- Soft tissue profile increased by an average of 4.01°, showing improvement in profile concavity
	- Average increase of 1.64 mm in upper lip protrusion, an improvement, but still insufficient
Gaps in the research	–
9: Comparison of orthodontic and orthopedic effects of a modified maxillary protractor between deciduous and early mixed dentitions (Kajiyama et al., 2004)	
Year	2004

Authors	Kajiyama, K. ; Murakami, T. ; Suzuki, A.
Journal of publication	American Journal of Orthodontics & Dentofacial Orthopedics
Type of study	Clinical trial
Database	PubMed
Participants	66 children (5 years and 6 months old ± 10 months)
Type of malocclusion corrected	Class III & Posterior crossbite
Intervention	JFO (Maxillary Protactor Bow Appliance – MPBA)
Duration of the intervention	5 months

Methodology	- Treatment Group (TG): 11 boys and 23 girls, with Class III malocclusion and anterior crossbite, treated with MPBA
	- Control Group (CG): 10 boys and 22 girls, with Class III malocclusion and anterior crossbite, without treatment

Results/Conclusions	- No significant differences in angular cephalometric analysis between the TG (treated with MPBA therapy) and the CG (control group)
	- Significant differences in facial height length (N-ANS, N-Me) and mandibular length (Ar-Me, A-Pog, Go-Me) tend to be greater in the TG than in the CG

	- Maxillary advancement with mandibular retrusion and clockwise mandibular displacement in the TG
	- Lesser maxillary forward growth and greater mandibular forward growth in the CG. These changes were altered in the TG

	- Anterior crossbite treated in the TG by maxillary advancement, clockwise mandibular displacement, proclination of upper incisors, and retroclination of lower incisors
Gaps in the research	–

Table 2: Detailed list of studies selected and their results.

The risk of bias included in this Scoping Review was checked by the Cochrane visualisation tool for assessing the risk of bias in a systematic review - Robvis (Generic), using version ROB 2.0. This tool allows articles to be assessed in five different ways. The Overall Risk-of-Bias Assessment Chart of the selected studies and its associated Graph are visible in **Figure 2** and **Figure 3**, respectively.

Figure 2: Overall Risk-of-Bias Assessment Chart of the studies used for this research, carried out with RobTool version ROB 2.0

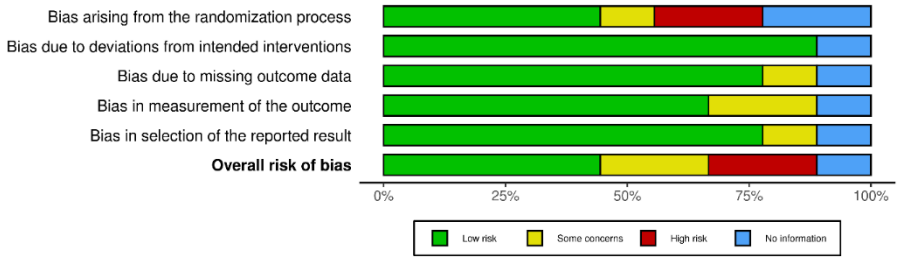

Figure 3: Overall Risk-of-Bias Assessment Graph of the studies used for this research, carried out with RobTool version ROB 2.0

Discussion

The importance of this investigation results in the search for scientific evidence on a topic that is still little known, which the application at an early age could prevent any other type of more invasive and costly treatment for the patient. The Scoping Review format allows to map the literature on a particular topic or area of research in order to identify key concepts and possible gaps. The main aim of the Scoping Review is to provide a descriptive overview of the studies reviewed. Here, the aim is to track evidence and anticipate potential.

Elimination of deleterious habits

According to the narrative review Timetable for oral prevention in childhood - developing dentition and oral habits: a current opinion, led by [14] oral habits with sufficient frequency, duration and intensity have an impact on dento-alveolar and skeletal deformation. Parafunctional habits lead to an increase in overjet, a reduction in overbite, posterior crossbite, and an increase in facial height. Prolonged non-nutritive swallowing has been associated with anterior open bite and posterior crossbite. [10] describe in the literature the preventive role of timely cessation of deleterious habits in averting occlusal pathologies and even reversing early-stage afflictions. Deleterious habits in a child's daily life can affect essential functions like eating, breathing, and speaking. These learned and often unconscious behaviours, including object biting and pacifier use, disrupt the normal growth and development of the stomatognathic system due to their frequency, duration, and intensity.

Intervention to halt parafunctional behaviours becomes imperative upon the onset of associated pathologies, with cessation of non-nutritive sucking habits recommended by age 2 to prevent lasting effects by age 3 [14]. Breastfeeding emerges as a crucial factor in promoting normal jaw development, in contrast to artificial feeding methods, which may predispose to malocclusions and non-nutritive sucking habits [14,15], as previously reported in the literature by [16,3,17] agree that in patients with open bite, the resolution of non-nutritive sucking habits (digital or pacifier) should be the first line of treatment, since they do not provoke physiological neuromuscular stimuli. Studies by Ipster [17] underline the importance of habit cessation in improving outcomes and reducing relapses. [14] and [1] state that inadequate nasal

breathing, often due to hypertrophied adenoids, contributes to facial height increase, open bite, and other skeletal discrepancies [1,3,14,18,19].

In the article Efectos del tratamiento temprano en las variables funcionales con técnicas de la rehabilitación neuro-oclusal, [11] describe the efficacy of early intervention, employing techniques like selective wear alongside habit cessation and dietary adjustments to address occlusal issues in children with deciduous dentition. Their longitudinal study demonstrates significant reductions in deleterious habits and long-term stability in occlusal correction, emphasizing the pivotal role of early habit cessation in resolving and maintaining balanced occlusion.

The authors of the selected studies and the literature consulted converge in recognizing the impact of deleterious habits on the origin of occlusal problems, as well as the importance of prompt intervention to reverse the pathological condition.

Selective wear

The selective wear technique of occlusal interferences is recommended by several authors, such as Planas, [7,20] Simões, [9,21] Belanger, [22-24].

Following on from the aforementioned article, entitled Efectos del tratamiento temprano en las variables funcionales con técnicas de la rehabilitación neuro-oclusal, [11] illustrate the efficacity of the technique, showing a high percentage of children achieving bilateral mastication and optimal chewing function after short-term treatment. Long-term results demonstrate complete resolution of occlusal interferences and sustained improvement in alternating bilateral chewing, with significant results and stability.

According to [17] the correct replacement of the deciduous dentition with a permanent dentition must take place in the presence of a physiological occlusal plane and mandibular dynamics free of occlusal interferences. [25] adds that bilateral chewing stimulates growth on both sides of the mandible in the same way and intensity, allowing for uniform and symmetrical development. [26] also describe the use of selective wear in the treatment of functional posterior crossbite in a longitudinal study, in their article Assessment of treatment for functional posterior cross-bites in patients at the deciduous dentition phase. The results of this study showed significant improvements in the correction of posterior crossbite in children by the adjustment of premature contact through this technique, when compared to the control group. [27] report a 64% success rate in resolving posterior crossbite using selective wear.

Selective wear therefore appears to be effective in the treatment of functional posterior crossbite in primary dentition, although it is necessary to deepen the results by following up the treated cases over time [26].

Direct Planas Tracks

Direct Planas Tracks, recommended by multiple authors, [28] are used to correct various types of malocclusions [17,29-31] and achieve balanced occlusal function [32]. Study Cambios de los arcos dentales deciduos classe I con apiñamiento, utilizando pistas planas directas. [32] shows that the Direct Planas

Tracks produced significant changes in transverse development and reduction in dental crowding, particularly in the maxilla, when compared to untreated patients. In the mandibular arch, however, no significant differences in length were observed. This confirms that the increase made by the use of this technique is greater in the maxilla than in the mandible, as reported by Tsujino and Machida in their study [33].

The effectiveness of Planas' Direct Tracks in correcting functional posterior crossbite is highlighted by [3] in their study, Neuroclusal rehabilitation and planas direct tracks in posterior crossbite treatment, resulting in the midline deviation correction of the children of the sample, and cessation of deleterious sucking habits, in a short period, with significant results.

In Evaluation of treatment for functional posterior crossbite of the deciduous dentition using Planas' direct tracks, [34] corroborate the efficacy of Planas' Direct Tracks in the early treatment of unilateral posterior functional crossbite. The results showed an increase in the intercanine and intermolar distance in the test group, greater than in the control group [35] observed similar results. This is in line with the principles formulated in the literature, i.e., these tracks facilitate physiological occlusal alignment and mandibular dynamics, leading to favourable growth patterns and occlusal harmony [8,36].

[37] explain in Efficacy of Planas Direct Tracks for Early Treatment of Pseudo Class III Malocclusion: A Clinical and Cephalometric Study, the role of these tracks in the early treatment of pseudo class III and anterior crossbite. The results demonstrated that the technique is an effective treatment option for pseudo class III and anterior crossbite at an early age. As stated by Echeverry and [38] Planas Direct Tracks is a good therapeutic option in deciduous dentition to re-establish a physiological occlusal plane with freedom of laterality movements, allowing the excitation and rehabilitation of facial growth vectors and the function of the TMJ in mandibular dynamics.

Despite the limitations of the studies presented here using Direct Planas Tracks, the technique used proved to be effective in correcting class I malocclusion, posterior crossbite, and anterior crossbite. This result is in line with reports in the specialized literature in this area.

Indirect Planas Tracks

For this Scoping Review, no studies were found to date that demonstrated the impact of using this technique in deciduous dentition in the treatment of any type of malocclusion, and that met the inclusion criteria defined in the scope of this research.

Functional Jaw Orthopaedics (FJO)

Functional orthopaedic appliances have been described in the literature as capable of modifying the relationships between teeth, bones, and facial muscles. The force generated stimulates bone growth and the development of occlusion [39] by promoting different morphological conditions in dental and skeletal structures [40]. They are used to treat all types of malocclusions, as described by Simões [9].

Kharbanda and Chaurasia detail the use of functional orthopaedic appliances in the treatment of class II malocclusion and how they can be used to intercept the onset of this skeletal condition [41]. Herrera Navarrete and [42] specify that the Bionator favours a postural change in the mandible and redirects maxillary growth, positioning the FJO as an alternative in the early treatment of patients with skeletal and dental malocclusions. [43] support that treatment with FJO improves masticatory efficiency, as well as enhancing aesthetics.

Considering the parameters established for this investigation, no relevant evidence was identified that met the stipulated inclusion criteria, resulting in a reduction in the sample of orthopaedic devices addressed in this study, as well as the diversity of malocclusions corrected in the articles examined. Given the wide variety of functional orthopaedic devices available, only a selection of these will be presented in this paper.

The Bionator and Maxillary Pad Movable Appliance (MPBA) are highlighted for their effectiveness in treating class III malocclusions [44-46].

The article The Effect of combined maxillary pad movable appliance and FR-III functional appliance in the treatment of skeletal Class III malocclusion of deciduous teeth, reporting on the investigation carried out by [44] presents the results of combining two orthopaedic appliances in the treatment of skeletal Class III. The use of the MPBA, combined with the FR-III afterwards, showed overall results of a significant improvement in the use of this orthopaedic appliances in the early treatment of class III malocclusion.

The effectiveness of the MPBA in temporary dentition was also analysed in a clinical trial in the article Comparison of orthodontic and orthopedic effects of a modified maxillary protractor between deciduous and early mixed dentitions, written by [45]. The results revealed quantitative changes in various parameters, which conducted to the rapid resolution of class III malocclusion and anterior crossbite in the treated group [47] found similar results with the use of MPBA in the treatment of class III malocclusion, where they concluded that this orthopaedic appliance was effective in treating an inverted skeletal occlusion.

However, with the articles selected here, we can only comment on the impact of a certain type of appliance on a certain type of malocclusion, so the results of this research, focused on this technique, are inconclusive.

Conclusions

Although established for some time, Neuro-Occlusal Rehabilitation (NOR) remains a controversial therapeutic approach in the treatment of malocclusion, particularly due to its limited popularity in Orthodontics and the scarcity of robust scientific evidence. The use of NOR in deciduous dentition appears theoretically interesting for guiding the growth vectors of craniofacial structures in developing children.

Various therapeutic techniques have emerged from this treatment philosophy, with some implementation in orthodontic clinical practice. This study also indicated that the cessation of deleterious habits to prevent the onset of malocclusion is recommended when a habit is related to the unfavorable

development of the stomatognathic system. Early elimination of daily deleterious habits in children proves fundamental in the spontaneous treatment of certain pathological conditions and in preventing recurrences.

Selective grinding is presented as an easy solution addressing a basic etiological problem of malocclusion — interferences. By eliminating this factor and allowing proper free movements of the mandible, this therapy offers a genuine solution to occlusal problems, particularly when implemented at an early age, thus characterized as “true prophylaxis” in this orthodontic philosophy.

This Scoping Review observed that the techniques could be complementary and used together. Some studies in this research revealed that combining therapies presents an excellent treatment option for malocclusion in deciduous dentition, with long-term stability of results.

According to this review, Planas Direct Tracks constitute an excellent method for reorienting dental movement through the redirection of forces, achieved by appropriate neural excitation. This has an impact on the posture of the bone bases, muscle tone, facial remodelling, and occlusal harmonization. The Scoping Review presented satisfactory results with this therapy in various types of malocclusions.

Planas Indirect Tracks did not present viable scientific evidence within this investigation, making it impossible to ascertain the efficiency of this technique in Neuro-Occlusal Rehabilitation within the context of primary dentition. Functional Jaw Orthopaedics, despite its popularity in current Orthodontics, remains a treatment philosophy with limited scientific evidence in a very early context. However, it was shown in some cases that orthopaedic appliances play a crucial role in correcting malocclusions in deciduous dentition, promoting not only balanced occlusion but also overall facial harmony.

Many of the analysed studies use only selective grinding or Direct Tracks without resorting to removable appliances, demonstrating that when identified early, i.e., in deciduous dentition, malocclusion can be intercepted in a short time with minimally invasive techniques, which are the principles on which Neuro-Occlusal Rehabilitation bases its philosophy. Early intervention allows the redirection of craniofacial growth before development is nearly complete.

In summary, the combination of this therapeutic approach appears to provide significant benefits in the early treatment of malocclusion in children with deciduous dentition, both functionally — skeletally and dentally — and aesthetically, by eliminating occlusal disharmonies and promoting correct craniofacial development. However, the results of this study are limited by the lack of scientific evidence supporting this line of thought in the context of primary dentition. Thus, it is not possible to assert the efficacy of a specific technique for a particular type of malocclusion with certainty, highlighting the need for further studies to support these claims.

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